

(19)



(11)

EP 3 328 721 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:

11.03.2020 Bulletin 2020/11

(51) Int Cl.:

B62K 5/01 (2013.01) **B62D 9/02** (2006.01)
B62K 5/027 (2013.01) **B62K 5/08** (2006.01)
B62K 5/10 (2013.01) **B62K 5/00** (2013.01)

(21) Application number: **16763947.5**

(86) International application number:

PCT/IB2016/054524

(22) Date of filing: **28.07.2016**

(87) International publication number:

WO 2017/017639 (02.02.2017 Gazette 2017/05)

(54) **MOTOR VEHICLE FRONT SUSPENSION**

VORDERRADAUFHÄNGUNG EINES KRAFTFAHRZEUGES

SUSPENSION AVANT D'UN VÉHICULE AUTOMOBILE

(84) Designated Contracting States:

**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**

Designated Extension States:

BA ME

Designated Validation States:

MA MD

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(30) Priority: **29.07.2015 IT UB20152613**

(43) Date of publication of application:

06.06.2018 Bulletin 2018/23

(56) References cited:

WO-A1-2005/075278 WO-A1-2013/005007

CN-B- 101 774 414 US-B1- 7 487 985

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Description

FIELD OF APPLICATION

[0001] The present invention relates to a forecarriage of a tilting motor vehicle and a motor vehicle thereof.

STATE OF THE ART

[0002] As is known, three-wheeled motor vehicles exist in the art with a rear drive wheel and two steering and tilting wheels. i.e. rolling or inclining, at the front.

[0003] Therefore, the rear wheel is intended to provide torque and thus allow traction while the front wheels, paired, are intended to provide the directionality of the vehicle.

[0004] Using two front wheels, instead of two rear wheels, avoids the use of a differential for torque transmission. This way a reduction of costs and weights at the rear axle can be achieved.

[0005] The paired wheels at the forecarriage in addition to steering, can tilt and roll: this way, compared with the three-wheeled vehicles with two wheels at the rear axle, vehicles with two wheels at the forecarriage are equivalent to an actual motorbike since, just like a motorbike, the vehicle is able to tilt when cornering.

[0006] Compared to a motor vehicle with only two wheels, such vehicles with two paired wheels on the forecarriage have however a greater stability ensured by the dual resting on the ground of the front wheels, similar to that provided by a car.

[0007] The front wheels are kinematically connected to each other by means of kinematic mechanisms which enable the same to roll and/or steer synchronously and in a specular manner for example through the interposition of articulated quadrilaterals.

[0008] As regards the steering angle of the front wheels, it is also possible to provide for different steering angles between the front wheels, for example if you take a car type steering, where the outer wheel remains more open when cornering.

[0009] Tilting three-wheeled motor vehicles are thus designed to provide the user with the handling of a two-wheel motorcycle and, at the same time, the stability and safety of a four-wheeled vehicle.

[0010] In fact the two predefined goals are antithetical since greater stability requires the presence of additional elements compared to a two-wheeled motor vehicle (such as the third wheel and its relative kinematic mechanisms) which inevitably weigh down the structure of the vehicle.

[0011] Moreover, the presence of 'only' three wheels cannot per force guarantee the stability and roadholding of a four-wheeled vehicle.

[0012] Therefore, it is essential to develop a three-wheeled vehicle that can mediate these antithetical objectives, while ensuring stability and handling, as well as reliability and low costs.

[0013] To achieve such purposes a specific geometry of the front portion of the frame or forecarriage must be developed, responsible for supporting the front wheels in their steering and rolling or tilting movement.

PRESENTATION OF THE INVENTION

[0014] To resolve the aforesaid problems, to date many solutions have been adopted in the art of three-wheeled vehicles, of which two on the forecarriage.

[0015] Such solutions of the prior art fail to optimise the need for stability and handling described above. Such solutions are disclosed, for example, in US 7487985 B1, WO 2013/005007 A1 and WO 2005/075278 A1.

[0016] The need is therefore felt to resolve the drawbacks and limitations mentioned with reference to the prior art.

[0017] This requirement is satisfied by a motor vehicle forecarriage according to claim 1 and by a motor vehicle according to claim 26.

DESCRIPTION OF THE DRAWINGS

[0018] Further characteristics and advantages of the present invention will be more clearly comprehensible from the description given below of its preferred and non-limiting embodiments, wherein:

figure 1 is a partial perspective view of a motor vehicle comprising a forecarriage according to the present invention;

figure 2 shows a side view of the motor vehicle in figure 1 from the side of the arrow II in figure 1;

figure 3 shows a front view of the motor vehicle in figure 1 from the side of the arrow III in figure 1;

figure 4 shows a plan view of the motor vehicle in figure 1 from the side of the arrow IV in figure 1;

figures 5-6 show partial perspective views of motor vehicle forecarriages according to the present invention;

figures 7a-7b respectively shows a perspective view and a cross-section view of a suspension applied to a motor vehicle according to the present invention;

figure 8 shows a partial perspective view of a wheel of the motor vehicle according to the present invention;

figures 9-10 show partial side views of motor vehicle forecarriage components according to the present invention;

The elements or parts of elements common to the embodiments described below will be indicated using the same reference numerals.

DETAILED DESCRIPTION

[0019] With reference to the aforementioned figures, reference numeral 4 globally denotes a schematic overall

view of a motor vehicle according to the present invention.

[0020] For the purposes of the present invention, it should be pointed out that the term motor vehicle should be considered in a broad sense, encompassing any motor cycle having at least three wheels, i.e. two aligned wheels, as described better below and at least one rear wheel. Such definition therefore also comprises so-called quad bikes having two wheels on the forecarriage and two wheels on the rear axle.

[0021] The motor vehicle 4 comprises a frame 6 extending from a forecarriage 8, supporting at least two front wheels 10, to a rear axle 12 supporting one or more rear wheels 14. It is possible to distinguish a left front wheel 10' and a right front wheel 10" in which the definition of left and right 10', 10" is purely formal and means in relation to a driver of the vehicle. Said wheels are arranged to the left and right of the centreline plane M-M of the motor vehicle, compared to a point of observation of a driver driving it.

[0022] In the following description, and also in the drawings, reference will be made to symmetrical or specular elements of the forecarriage with respect to said centreline plane M-M using the quotes ' and ' ' to indicate respectively the components to the left and right of the forecarriage, compared to a point of observation of a driver driving it.

[0023] For the purposes of the present invention, the frame 6 of the motor vehicle may be any shape, size and may for example be of the lattice type, box type, cradle, single or double, and so forth.

[0024] The frame 6 of the motor vehicle can be in one piece or in multiple parts; for example the frame 6 of the motor vehicle interconnects with a rear axle frame 13 which may comprise an oscillating rear fork (not shown) which supports one or more rear drive wheels 14.

[0025] Said rear oscillating fork may be connected to the frame 6 by direct hinging, or by the interposition of a lever mechanism and/or intermediate frames.

[0026] The motor vehicle forecarriage 8 comprises a forecarriage frame 16 and a pair of front wheels 10 kinematically connected to the forecarriage frame 16 by means of an articulated quadrilateral 20.

[0027] The articulated quadrilateral 20 comprises a pair of cross members 24 hinged to the forecarriage frame 16 in correspondence of middle hinges 28.

[0028] The middle hinges 28 identify middle hinge axes W-W parallel to each other.

[0029] For example said middle hinges are fitted on a front beam 32, positioned to straddle a centreline plane M-M passing through a longitudinal direction X-X or the direction of travel of the motor vehicle.

[0030] For example, a steering mechanism 36, connected to a handlebar (not shown) of the motor vehicle 4, is pivoted on a steering column 35 inserted so as to swivel in a steering tube 34 of the frame 6 of the motor vehicle 4.

[0031] The cross members 24 extend in a main trans-

verse direction Y-Y between opposite transverse ends 40, 44.

[0032] In particular, said cross members 24 are connected together, in correspondence of said opposite transverse ends 40, 44, by means of uprights 48, pivoted to said transverse ends 40, 44 in correspondence of side hinges 52.

[0033] In one embodiment the cross members 24, 24', 24" are mounted cantilevered with respect to the front beam 32.

[0034] The cross members 24 and the uprights 48 define said articulated quadrilateral 20. In particular the quadrilateral comprises two cross members 24, i.e. a top cross member 24' and a bottom cross member 24", in which the top cross member is facing the side of the associated handlebar and the bottom cross member 24" is facing towards the ground supporting the motor vehicle.

[0035] The cross members are not necessarily the same as each other in terms of shape, materials and size; each cross member 24 can be made in one piece or in two or more parts mechanically attached, for example by welding, bolts, rivets and similar.

[0036] There are two uprights 48, in particular a left upright 48' and a right upright 48".

[0037] The definition of left and right upright 48', 48" is purely formal and means in relation to a driver of the vehicle. Said left and right uprights 48', 48" are arranged to the left and right of a centreline plane M-M of the motor vehicle, compared to a point of observation of a driver driving it.

[0038] The side hinges 52 are parallel to each other and define respective side hinge axes Z-Z.

[0039] Preferably, said middle 28 and side hinges 52 are oriented according to middle W-W and side Z-Z hinge axes parallel to each other.

[0040] The left and right uprights 48', 48" rotatably support the left and right front wheels 10', 10", respectively, around respective steering axes S'-S', S"-S". Said steering axes S'-S', S"-S" are parallel to each other.

[0041] According to a possible embodiment, the hinges 28 and 52 are parallel to each other and perpendicular to said steering axes S'-S', S"-S". In other words, according to one embodiment, compared to a projection plane P passing through said middle hinges 28, the steering axes S'-S', S"-S" identify with the middle W-W and lateral hinge axes an angle α of 90 degrees.

[0042] According to possible embodiments, said angle α is between 80 and 120 degrees and preferably said angle α is between 90 and 110 degrees; even more preferably said angle value α is equal to 100 degrees.

[0043] The steering axes S'-S', S"-S" with respect to said projection plane P, may be inclined by a steering angle β between 5 and 20 degrees, and preferably between 8 and 16 degrees with respect to a vertical direction N-N, perpendicular to the ground.

[0044] According to further embodiments, it is also possible to provide that the hinges 28 and 52 are tilted according to middle W-W and lateral hinge axes Z-Z side

parallel to the ground, i.e. perpendicular to said vertical direction N-N with respect to said projection plane P: in this configuration, said angle β is equal to 0 degrees

[0045] Furthermore, as seen, it is also possible to provide that the hinges 28 and 52 are not perpendicular to the steering axes S'-S', S"-S": in fact, as described above, said angle α , defined between the steering axes S'-S', S"-S' and the middle W-W and side hinges Z- Z with respect to a projection plane P passing through said middle hinges 28, may be comprised between 80 and 120 degrees and, preferably, said angle α is comprised between 90 and 110 degrees; even more preferably said angle α value is equal to 100 degrees.

[0046] The parallelism to the ground of the middle W-W and side hinge axes Z-Z means that, in the rolling motion, the inner wheel with respect to the curve rises upwards almost vertically with the double advantage of uncoupling the rolling motion of the wheel from horizontal braking forces (transmitted from the ground) and of taking up less space towards the bottom of the motor vehicle.

[0047] It should be noted that, by tilting the middle W-W and side axes Z-Z with respect to the steering axes S'-S', S" - S", so that in static conditions at rest said middle W-W and side hinge axes Z-Z are parallel to the ground, in braking conditions, and therefore compression of the suspensions of the front wheels 10', 10", said middle W-W and side hinge axes Z-Z are inclined moving into a condition of substantial parallelism to the ground. For example, looking at figure 10, if in static conditions the middle W-W and side hinge axes Z-Z identify an angle β different from zero with the horizontal direction (which coincides with the angle formed with the vertical direction, which is perpendicular to the horizontal direction), in braking and maximum compression conditions this angle tends to zero.

[0048] When, during braking, the middle W-W and side hinge axes Z-Z are arranged substantially parallel to the ground, the jumping of the wheels is avoided since the braking forces, horizontal and therefore parallel to the ground, do not produce components along the excursion movement of the wheels which is practically perpendicular to the ground, i.e. vertical.

[0049] Each of the uprights 48 guides and supports a stub axle 56 of a front wheel 10; each upright 48 extends from an upper end 60 to a lower end 64. The top end 60 is facing towards the upper cross member 24' and the lower end 64 is facing the bottom cross member 24".

[0050] According to one embodiment, each stub axle 56 is mechanically connected to a rotation pin 68 of a front wheel 10 so as to rotatably support the front wheel 10 around a related rotation axis R-R.

[0051] Advantageously, each rotation pin 68 of the front wheel 10 is comprised between the upper end 60 and the lower end 64 of the corresponding upright 48 of the articulated quadrilateral 20.

[0052] Preferably, each rotation pin 68 of each front wheel 10 is comprised between adjacent side hinges 52 of the cross members 24 of the articulated quadrilateral

20.

[0053] The stub axle 56 of each wheel 10 is supported and guided by a single corresponding upright 48 of said articulated quadrilateral 20.

[0054] According to one embodiment, each stub axle 56 is mounted on a corresponding upright 48 so as to have at least one degree of freedom with respect to the corresponding upright 48, said at least one degree of freedom comprising a translational movement of the stub axle 56 with respect to the upright 48 parallel to an axis of prevalent extension T-T of the upright 48 and/or a rotational motion of the stub axle 56 about said axis of prevailing extension T-T of the upright 48.

[0055] According to a possible embodiment, the coupling between each stub axle 56 and the upright 48 is of the prismatic type, so as to allow only one degree of freedom to the stub axle 56 with respect to the upright 48, i.e., a translation of the stub axle 56 with respect to the upright 48 parallel to the main extension axis T-T of the upright 48. Said translation motion is also called shaking motion of the stub axle 56 and of the relative front wheel 10 connected thereto, which thus moves along a substantially straight trajectory.

[0056] Thanks to the prismatic coupling between each stub axle 56 and the corresponding upright 48, it is necessary to introduce a further element between the stub axle 56 and the respective guide so as to enable the steering of the wheel. In this way there is the possibility to offset the steering axis S-S of each front wheel 10 from a symmetry axis or axis of prevalent extension T-T of each upright 48; moreover with this configuration there is the possibility to have different inclinations between the steering axis S-S and the relative axis of prevalent extension T-T of each upright 48. Therefore it is possible to optimize the inclination of the steering axis S-S for improve the trail of the wheel; moreover it is possible to optimize the inclination of the axis of prevalent extension T-T of the upright for the bumping trajectory of the wheel and for the overall size with respect to the vehicle. Moreover, the stub axle 56 has not the function to contain the guide of each upright and it can be optimized to support the wheel during its rolling. For example it is possible to optimize the dimension and/or positioning of rolling bearings within the stub axle 56.

[0057] According to a further embodiment, the coupling between each stub axle 56 and the upright 48 is of the cylindrical type, so as to allow both translation and rotation of the stub axle 56 with respect to the axis of prevalent extension T-T of the upright 48.

[0058] Preferably, each front wheel 10 has a steering axis S-S that coincides with the axis of prevalent extension T-T and of symmetry of the upright 48 of the cylindrical type.

[0059] In addition, it should be noted that the middle hinges 28 and side hinges 52, which define the respective middle W-W and side axes Z-Z, are placed above and below the rotation pin 68 of the respective front wheels 10', 10" and not completely over it, as occurs in the so-

lutions of the prior art. In other words, with respect to the main extension axis T-T of each upright 48, each rotation pin 68 of the front wheel 10', 10" is comprised between the middle 28 and side hinges 52 respectively of the upper 24' and lower cross member 24" of the articulated quadrilateral.

[0060] This implies that the stiffness of the connection between each wheel 10', 10" and the articulated quadrilateral, comprising the suspension, is a more rigid order of magnitude than happens in the aforementioned solutions of the prior art, helping to make the possibility more remote that an alternating resonance of the front wheels 10', 10" may take overdue to braking forces or an asymmetric impact. Consequently the present invention helps overall to provide a vehicle that is lightweight but also safe, precise and that conveys to the driver a feeling of safety at the forecarriage, in that it does not transmit to the user vibrations or flickering on the handlebar.

[0061] Furthermore, the positioning of the upper and lower 24', 24" cross members of the articulated quadrilateral in the vertical dimension of the wheels makes it possible to move the barycentre of the forecarriage, and therefore of the vehicle, downwards, improving the dynamic behaviour of the vehicle .

[0062] As regards the steering of the front wheels 10, according to one embodiment the forecarriage 8 comprises at least one bracket 72, connected to the stub axle 56 of the front wheel 10 and to steering levers 76 of the forecarriage 8, so as to control the rotation of the stub axles 56 about the respective steering axis S-S of each front wheel 10.

[0063] Preferably, the bracket 72 is integral, in one piece, with the stub axle 56 of each front wheel 10.

[0064] According to one embodiment, said bracket 72 supports braking means 80 for the wheel 10.

[0065] For example, said braking means 80 comprise a calliper for disc brake arranged astride a brake disc 84 integral in rotation with the wheel 10.

[0066] Preferably, the bracket 72 extends astride the upright 48 from the side of the lower end 64 of the upright 48.

[0067] Thanks to this architecture, the whole suspension is centred with respect to the relative upright and it is possible to avoid transversal bending moments.

[0068] Preferably, the stub axle 56 comprises a sleeve 88 placed coaxially to the upright 48.

[0069] According to one embodiment, between the stub axle 56 and the upright 48 are arranged suspension means 92 of the wheel 10.

[0070] For example, the suspension means 92 comprise a spring 94 and/or a damper 96.

[0071] According to one embodiment, the uprights 48 are hollow so as to house internally, at least partially, the suspension means.

[0072] The positioning of the suspension means within the uprights implies some advantages: for example the upright protect the suspension means, and it works in a purely compressive state, avoiding bending moments.

[0073] Preferably the suspension means 92 are arranged coaxially to the respective upright 48.

[0074] Each wheel 10 comprises a wheel rim 100 which supports a tyre 102 and that is rotatably supported by the related stub axle 56, wherein the stub axle 56 is at least partially housed in a volume delimited by said wheel rim 100.

[0075] Preferably, the stub axle 56 and the upright 48 are integrally housed in said volume delimited by the wheel rim 100.

[0076] In a preferred embodiment, each centreline plane of the wheel R'-R', R"-R" goes through the steering axis S'-S', S"-S" of each front wheel 10', 10".

[0077] In a further embodiment, an offset or transverse overhang is provided between each steering axle S'-S', S"-S" and the relative centreline plane of the wheel R'-R', R"-R". Such transverse overhang is between 0 and 2 cm , more preferably between 0 and 1 cm, even more preferably said transverse overhang is equal to 0.7 cm.

[0078] Preferably, said volume bounded by the wheel rim 100 is facing with respect to a centreline plane M-M of the forecarriage passing through said middle hinges 28. In other words, the stub axles 56 are facing inward towards the centreline plane M-M of the motor vehicle and the relative components associated with the stub axles 56 are not directly visible to an outside observer.

[0079] As mentioned above, the vehicle 4 according to the present invention comprises at least one rear drive wheel drive 14; according to a possible embodiment, the vehicle has two rear drive wheels 14 at the rear axle 12 .

[0080] For example, in this embodiment, in which the motor vehicle is a quadricycle, the rear drive wheels 14 at the rear axle 12 are connected to each other and to a rear axle frame 13 by means of an articulated quadrilateral 20 as described above in relation to the front wheels 10.

[0081] As may be appreciated from the description, the present invention makes it possible to overcome the drawbacks mentioned of the prior art.

[0082] In particular, the forecarriage has limited dimensions and weight.

[0083] In particular, the dimensions are particularly reduced given that all the main elements of the forecarriage are enclosed inside the footprint of the articulated quadrilateral.

[0084] In addition, the forecarriage components are at least partially contained in the volume delimited by each wheel rim.

[0085] The solution thus proves particularly compact.

[0086] Furthermore, the solution presents a particularly contained non-suspended mass since it is constituted solely by the wheel and by its relative stub axle.

[0087] The described solution falls within the case of interconnected suspensions since the balance to a load on a front wheel is found with an equal load on the conjugated front wheel; the load transfer occurs through the quadrilateral, and thus by means of its inertia which also involves that of the entire vehicle, and thus presents a

delay of an entity related to said inertia.

[0088] In practice, the inertia interposed between the paired wheels acts so as to move the solution with inter-connected wheels towards one with independent wheels favouring comfort and counteracting any resonance phenomena that could be triggered on the wheels, which would otherwise not be damped.

[0089] Therefore the motor vehicle according to the present invention is able to guarantee not only high stability, superior to that of a motor vehicle with two wheels, thanks to the presence of two paired front wheels, but also remarkable handling and ease of leaning, typical of a motor vehicle with only two wheels.

[0090] In addition, as described, the middle hinges and side hinges, which define the respective middle and side axes, are placed above and below the rotation pin of the respective front wheels and not completely over it, as occurs in the solutions of the prior art. This way, with respect to the main extension axis of each upright each rotation pin of the front wheel is comprised between the middle and side hinges respectively of the upper and lower cross member of the articulated quadrilateral. This implies that the stiffness of the connection between each wheel and the articulated quadrilateral, comprising the suspension, is a more rigid order of magnitude than happens in the aforementioned solutions of the prior art, helping to make the possibility more remote that an alternating resonance of the front wheels may take overdue to braking forces or an asymmetric impact. Consequently the present invention helps overall to provide a vehicle that is lightweight but also safe, precise and that conveys to the driver a feeling of safety at the forecarriage, in that it does not transmit to the user vibrations or flickering on the handlebar.

[0091] A person skilled in the art may make numerous modifications and variations to the solutions described above so as to satisfy contingent and specific requirements while remaining within the sphere of protection of the invention as defined by the following claims.

Claims

1. Motor vehicle forecarriage (8) comprising

- a forecarriage frame (16),
- a pair of front wheels (10', 10'') kinematically connected to the forecarriage frame (16) by means of an articulated quadrilateral (20),
- said articulated quadrilateral (20) comprising a pair of cross members (24', 24''), hinged to the forecarriage frame (16) in correspondence of middle hinges (28),
- said cross members (24', 24'') being connected together, in correspondence of opposite transverse ends (40, 44), by means of uprights (48', 48'') pivoted to said transverse ends (40, 44) in correspondence of side hinges (52),

- the cross members (24', 24'') and the uprights (48', 48'') defining said articulated quadrilateral (20), wherein

- each of the uprights (48', 48'') guides and supports a stub axle (56) of a front wheel (10', 10''), each upright (48', 48'') extending from an upper end (60) to a lower end (64),

- wherein each stub axle (56) is mechanically connected to a rotation pin (68) of the respective front wheel (10', 10'') so as to rotatably support the front wheel (10', 10'') around a rotation axis (R-R), and wherein each rotation pin (68) of the respective front wheel (10', 10'') is comprised between the upper end (60) and the lower end (64) of the corresponding upright (48', 48'') of the articulated quadrilateral (20), wherein between each stub axle (56) and the respective upright (48') are arranged suspension means (92) of the respective front wheel (10', 10''), **characterised in that** each of said uprights (48', 48'') is hollow so as to house internally, at least partially, said suspension means (92) of the respective front wheel (10', 10'').

2. Motor vehicle forecarriage (8) according to claim 1, wherein each rotation pin (68) of the respective front wheel (10) is comprised between adjacent side hinges (52) of the cross members (24) of the articulated quadrilateral (20).

3. Motor vehicle forecarriage (8) according to claim 1 or 2, wherein the stub axle (56) of each front wheel (10', 10'') is supported and guided by a single corresponding left and right upright (48', 48'') of said articulated quadrilateral (20).

4. Motor vehicle forecarriage (8) according to claim 1, 2 or 3, wherein the left and right uprights (48', 48'') rotatably support the left and right front wheels (10', 10''), respectively, around respective steering axes (S'-S', S''-S'') parallel to each other.

5. Motor vehicle forecarriage (8) according to claim 4, wherein the middle hinges (28) and the side hinges (52) are parallel to each other and are oriented so that, with respect to a projection plane (P) passing through said middle hinges (28), the steering axes (S'-S', S''-S'') identify, with the axes of the middle hinge (W-W) and side hinge (Z-Z), an angle (α), said angle α being between 80 and 120 degrees and, preferably, said angle (α) is between 90 and 110 degrees.

6. Motor vehicle forecarriage (8) according to claim 4 or 5, wherein the middle hinges (28) and the side hinges (52) are parallel to each other and orthogonal to said steering axes (S'-S', S''-S'') so that, with respect to a projection plane (P) passing through said

middle hinges (28) the steering axes (S'-S', S"-S") identify with the axes of the middle hinge (W-W) and side hinge (Z-Z), an angle (α) of 90 degrees.

7. Motor vehicle forecarriage (8) according to claim 4, 5 or 6, wherein the steering axes (S'-S', S"-S"), with respect to a projection plane (P) passing through said middle hinges (28), are inclined by a steering angle (β) between 5 and 20 degrees, and preferably between 8 and 16 degrees, with respect to a vertical direction (N-N), perpendicular to the ground.
8. Motor vehicle forecarriage (8) according to any of the preceding claims, wherein the middle hinges (28) and the side hinges (52) are inclined according to the axes of the middle hinge (W-W) and side hinge (Z-Z) parallel to the ground, i.e., perpendicular to a vertical direction (N-N) perpendicular to the ground.
9. Motor vehicle forecarriage (8) according to any of the preceding claims, wherein each stub axle (56) is mounted on a corresponding upright (48', 48") so as to have at least one degree of freedom with respect to the corresponding upright (48', 48"), said at least one degree of freedom comprising a translational movement of the stub axle (56) with respect to the upright (48', 48") parallel to an axis of prevalent extension (T-T) of the upright (48', 48") and/or a rotational motion of the stub axle (56) about said axis of prevalent extension (T-T) of the upright (48').
10. Motor vehicle forecarriage (8) according to claim 9, wherein the coupling between each stub axle (56) and the upright (48', 48") is of the prismatic type, so as to allow only one degree of freedom to the stub axle (56) with respect to the upright (48', 48"), i.e., a translation of the stub axle (56) with respect to the upright (48', 48") parallel to an axis of prevalent extension (T-T) of the upright (48', 48").
11. Motor vehicle forecarriage (8) according to claim 9, wherein the coupling between each stub axle (56) and the upright (48', 48") is of the cylindrical type, so as to allow both translation and rotation of the stub axle (56) with respect to the axis of prevalent extension (T-T) of the upright (48', 48").
12. Motor vehicle forecarriage (8) according to claim 11, wherein each front wheel (10', 10") has a steering axis (S'-S', S"-S") that coincides with the axis of prevalent extension (T-T) and of symmetry of the relative upright (48', 48") of the cylindrical type.
13. Motor vehicle forecarriage (8) according to any of the preceding claims, wherein the forecarriage (8) comprises at least one bracket (72), connected to the respective stub axle (56) of the respective front wheel (10', 10") and steering levers (76) of the fore-

carriage (8), so as to control the rotation of the respective stub axles (56) about the respective steering axis (S-S) of the respective front wheel (10', 10").

14. Motor vehicle forecarriage (8) according to claim 13, wherein said bracket (72) supports braking means (80) for the respective front wheel (10', 10").
15. Motor vehicle forecarriage (8) according to claim 14, wherein said braking means (80) comprise a calliper for disc brake arranged astride of a brake disc (84) integral in rotation with the front wheel (10', 10").
16. Motor vehicle forecarriage (8) according to claim 13, 14 or 15, wherein said bracket (72) extends astride the respective upright (48', 48") from the side of the lower end (64) of the respective upright (48', 48").
17. Motor vehicle forecarriage (8) according to any one of the preceding claims, in which the stub axle (56) comprises a sleeve (88) arranged coaxially to the upright (48', 48").
18. Motor vehicle forecarriage (8) according to any one of the preceding claims, wherein said suspension means (92) comprise a spring (94) and/or a damper (96).
19. Motor vehicle forecarriage (8) according to any of preceding claims, wherein said suspension means (92) are arranged coaxially to the respective upright (48', 48").
20. Motor vehicle forecarriage (8) according to any of the preceding claims, wherein each front wheel (10', 10") comprises a wheel rim (100) which supports a tyre (102) and that is rotatably supported by the related stub axle (56), wherein the respective stub axle (56) is at least partially housed in a volume delimited by said wheel rim (100).
21. Motor vehicle forecarriage (8) according to claim 20, wherein the respective stub axle (56) and the respective upright (48', 48") are integrally housed in said volume delimited by the wheel rim (100).
22. Motor vehicle forecarriage (8) according to claim 20 or 21, wherein said volume is facing with respect to a centreline plane (M-M) of the forecarriage (8) passing through said middle hinges (28).
23. Motor vehicle forecarriage (8) according to any of the preceding claims, wherein said middle hinges (28) and side hinges (52) are oriented according to the axes of the middle hinge (W-W) and side hinge (Z-Z) parallel to each other.
24. Motor vehicle (4) having a drive wheel at a rear axle

(12) and a forecarriage (8) according to any of claims 1 to 23.

25. Motor vehicle (4) according to claim 24, wherein the motor vehicle (4) comprises two rear drive wheels (14) at the rear axle (12).

26. Motor vehicle (4) according to claim 25, wherein said rear drive wheels (14) at the rear axle (12) are connected together and to a rear axle frame by means of an articulated quadrilateral (20) according to the articulated quadrilateral (20) of the forecarriage (8) of any one of claims 1 to 23.

Patentansprüche

1. Kraftfahrzeugvorderwagen (8), welcher aufweist:

- einen Vorderwagenrahmen (16),
- ein Paar von Vorderrädern (10', 10''), die mittels eines Gelenkvierecks (20) mit dem Vorderwagenrahmen (16) kinematisch verbunden sind,
- wobei das Gelenkviereck (20) ein Paar von Querelementen (24', 24'') aufweist, die entsprechend Mittelgelenken (28) an den Vorderwagenrahmen (16) angelenkt sind,
- wobei die Querelemente (24', 24'') entsprechend entgegengesetzten Querenden (40, 44) mittels Beinen (48', 48'') miteinander verbunden sind, die entsprechend Seitengelenken (52) an den Querenden (40, 44) angelenkt sind,
- wobei die Querelemente (24', 24'') und die Beine (48', 48'') das Gelenkviereck (20) definieren, wobei
- jedes der Beine (48', 48'') einen Achsschenkel (56) eines Vorderrads (10', 10'') führt und trägt, wobei sich jedes Bein (48', 48'') von einem oberen Ende (60) zu einem unteren Ende (64) erstreckt,
- wobei jeder Achsschenkel (56) mit einem Drehzapfen (68) des jeweiligen Vorderrads (10', 10'') mechanisch verbunden ist, um das Vorderrad (10', 10'') um eine Drehachse (R-R) drehbar zu tragen, und wobei jeder Drehzapfen (68) des jeweiligen Vorderrads (10', 10'') zwischen dem oberen Ende (60) und dem unteren Ende (64) des entsprechenden Beins (48', 48'') des Gelenkvierecks (20) angeordnet ist,
- wobei zwischen jedem Achsschenkel (56) und dem jeweiligen Bein (48) Aufhängungsmittel (92) des jeweiligen Vorderrads (10', 10'') angeordnet sind,
- **dadurch gekennzeichnet, dass** jedes der Beine (48', 48'') hohl ist, um die Aufhängungsmittel (92) des jeweiligen Vorderrads (10', 10'') zumindest teilweise im Inneren aufzunehmen.

2. Kraftfahrzeugvorderwagen (8) nach Anspruch 1, wobei jeder Drehzapfen (68) des jeweiligen Vorderrads (10) zwischen benachbarten Seitengelenken (52) der Querelemente (24) des Gelenkvierecks (20) angeordnet ist.

3. Kraftfahrzeugvorderwagen (8) nach Anspruch 1 oder 2, wobei der Achsschenkel (56) jedes Vorderrads (10', 10'') von einem einzelnen entsprechenden linken und rechten Bein (48', 48'') des Gelenkvierecks (20) getragen und geführt wird.

4. Kraftfahrzeugvorderwagen (8) nach Anspruch 1, 2 oder 3, wobei die linken und rechten Beine (48', 48'') die linken und rechten Vorderräder (10', 10'') jeweils um jeweilige zueinander parallele Lenkachsen (S'-S', S''-S'') drehbar tragen.

5. Kraftfahrzeugvorderwagen (8) nach Anspruch 4, wobei die Mittelgelenke (28) und die Seitengelenke (52) parallel zueinander sind und derart orientiert sind, dass, in Bezug auf eine durch die Mittelgelenke (28) hindurchgehende Projektionsebene (P), die Lenkachsen (S'-S', S''-S'') mit den Achsen des Mittelgelenks (W-W) und des Seitengelenks (Z-Z) einen Winkel (α) identifizieren, wobei der Winkel (α) zwischen 80 und 120 Grad liegt und bevorzugt der Winkel (α) zwischen 90 und 110 Grad liegt.

6. Kraftfahrzeugvorderwagen (8) nach Anspruch 4 oder 5, wobei die Mittelgelenke (28) und die Seitengelenke (52) parallel zueinander und orthogonal zu den Lenkachsen (S'-S', S''-S'') sind, sodass, in Bezug auf eine durch die Mittelgelenke (28) hindurchgehende Projektionsebene (P), die Lenkachsen (S'-S', S''-S'') mit den Achsen des Mittelgelenks (W-W) und des Seitengelenks (Z-Z) einen Winkel (α) von 90 Grad identifizieren.

7. Kraftfahrzeugvorderwagen (8) nach Anspruch 4, 5 oder 6, wobei die Lenkachsen (S'-S', S''-S''), in Bezug auf eine durch die Mittelgelenke (28) hindurchgehende Projektionsebene (P), um einen Lenkwinkel (β) zwischen 5 und 20 Grad, und bevorzugt zwischen 8 und 16 Grad in Bezug auf eine zum Boden senkrechte vertikale Richtung (N-N) geneigt sind.

8. Kraftfahrzeugvorderwagen (8) nach einem der vorhergehenden Ansprüche, wobei die Mittelgelenke (28) und die Seitengelenke (52) gemäß den Achsen des Mittelgelenks (W-W) und des Seitengelenks (Z-Z), parallel zum Boden, d.h. senkrecht zu einer vertikalen Richtung (N-N) senkrecht zum Boden, geneigt sind.

9. Kraftfahrzeugvorderwagen (8) nach einem der vorhergehenden Ansprüche, wobei jeder Achsschenkel (56) an einem entsprechenden Bein (48', 48'') so an-

- gebracht ist, dass er zumindest einen Freiheitsgrad in Bezug auf das entsprechende Bein (48', 48'') hat, wobei der zumindest eine Freiheitsgrad eine Translationsbewegung des Achsschenkels (56) in Bezug auf das Bein (48', 48'') parallel zu einer vorherrschenden Achserstreckung (T-T) des Beins (48', 48''), und/oder eine Drehbewegung des Achsschenkels (56) um die vorherrschende Achserstreckung (T-T) des Beins (48) aufweist.
10. Kraftfahrzeugvorderwagen (8) nach Anspruch 9, wobei die Kupplung zwischen dem Achsschenkel (56) und dem Bein (48', 48'') vom Prismentyp ist, um dem Achsschenkel (56) in Bezug auf das Bein (48', 48'') nur einen Freiheitsgrad zu erlauben, d.h. eine Translation des Achsschenkels (56) in Bezug auf das Bein (48', 48'') parallel zu einer vorherrschenden Achserstreckung (T-T) des Beins (48', 48'').
11. Kraftfahrzeugvorderwagen (8) nach Anspruch 9, wobei die Kupplung zwischen dem Achsschenkel (56) und dem Bein (48', 48'') vom zylindrischen Typ ist, um sowohl eine Translation als auch eine Drehung des Achsschenkels (56) in Bezug auf die vorherrschende Achserstreckung (T-T) des Beins (48', 48'') zu erlauben.
12. Kraftfahrzeugvorderwagen (8) nach Anspruch 11, wobei jedes Vorderrad (10', 10'') eine Lenkachse (S'-S', S''-S'') aufweist, die mit der vorherrschenden Achserstreckung (T-T) und der Symmetrie des entsprechenden Beins (48', 48'') des zylindrischen Typs übereinstimmt.
13. Kraftfahrzeugvorderwagen (8) nach einem der vorhergehenden Ansprüche, wobei der Vorderwagen (8) zumindest einen Träger (72) aufweist, der mit dem jeweiligen Achsschenkel (56) des jeweiligen Vorderrads (10', 10'') und Lenkhebeln (56) des Vorderwagens (8) verbunden ist, um die Drehung der jeweiligen Achsschenkel (56) um die jeweilige Lenkachse (S-S) des entsprechenden Vorderrads (10', 10'') zu steuern.
14. Kraftfahrzeugvorderwagen (8) nach Anspruch 13, wobei der Träger (72) Bremsmittel (80) für das jeweilige Vorderrad (10', 10'') trägt.
15. Kraftfahrzeugvorderwagen (8) nach Anspruch 14, wobei die Bremsmittel (80) einen Scheibenbremsattel aufweisen, der eine Brems Scheibe (84) überspannend angeordnet ist, die sich integriert mit dem Vorderrad (10', 10'') dreht.
16. Kraftfahrzeugvorderwagen (8) nach Anspruch 13, 14 oder 15, wobei sich der Träger (72) das jeweilige Bein (18', 48'') von der Seite des unteren Endes des jeweiligen Beins (48', 48'') überspannend erstreckt.
17. Kraftfahrzeugvorderwagen (8) nach einem der vorhergehenden Ansprüche, wobei der Achsschenkel (56) eine Hülse (88) aufweist, die coaxial zu dem Bein (48', 48'') angeordnet ist.
18. Kraftfahrzeugvorderwagen (8) nach einem der vorhergehenden Ansprüche, wobei die Aufhängungsmittel (92) eine Feder (94) und/oder einen Dämpfer (96) aufweisen.
19. Kraftfahrzeugvorderwagen (8) nach einem der vorhergehenden Ansprüche, wobei die Aufhängungsmittel (92) coaxial zum jeweiligen Bein (48', 48'') angeordnet sind.
20. Kraftfahrzeugvorderwagen (8) nach einem der vorhergehenden Ansprüche, wobei jedes Vorderrad (10', 10'') eine Radfelge (100) aufweist, die einen Reifen (102) trägt und die an dem betreffenden Achsschenkel (56) drehbar gelagert ist, wobei der jeweilige Achsschenkel (56) zumindest teilweise in einem von der Radfelge (100) begrenzten Volumen aufgenommen ist.
21. Kraftfahrzeugvorderwagen (8) nach Anspruch 20, wobei der jeweilige Achsschenkel (56) und das jeweilige Bein (48', 48'') in dem durch die Radfelge (100) aufgenommenen Volumen integriert aufgenommen sind.
22. Kraftfahrzeugvorderwagen (8) nach Anspruch 20 oder 21, wobei das Volumen zu einer Mittellinienebene (M-M) des Vorderwagens (M), die durch die Mittelgelenke (28) hindurchgeht, weist.
23. Kraftfahrzeugvorderwagen (8) nach einem der vorhergehenden Ansprüche, wobei die Mittelgelenke (28) und die Seitengelenke (52) gemäß den Achsen des Mittelgelenks (W-W) und des Seitengelenks (Z-Z) parallel zueinander orientiert sind.
24. Kraftfahrzeug (4), das ein Antriebsrad an einer Hinterachse (12) und einen Vorderwagen (8) nach einem der Ansprüche 1 bis 23 aufweist.
25. Kraftfahrzeug (4) nach Anspruch 24, wobei das Kraftfahrzeug (4) an der Hinterachse (12) zwei hintere Antriebsräder (14) aufweist.
26. Kraftfahrzeug (4) nach Anspruch 25, wobei die hinteren Antriebsräder (14) an der Hinterachse (12) miteinander und mit einem Hinterachsrahmen mittels eines Gelenkvierecks (20) gemäß dem Gelenkviereck (20) des Vorderwagens (8) nach einem der Ansprüche 1 bis 23 miteinander verbunden sind.

Revendications

1. Avant-train de véhicule automobile (8) comprenant

- un châssis d'avant-train (16),
 - une paire de roues avant (10', 10'') cinématiquement reliées au châssis d'avant-train (16) au moyen d'un quadrilatère articulé (20),
 - ledit quadrilatère articulé (20) comprenant une paire de traverses (24', 24'') articulées par rapport au châssis d'avant-train (16) en correspondance avec des charnières centrales (28),
 - lesdites traverses (24', 24'') étant reliées ensemble, en correspondance des extrémités transversales opposées (40, 44), au moyen de montants (48', 48'') pivotés vers lesdites extrémités transversales (40, 44) en correspondance avec des charnières latérales (52),
 - les traverses (24', 24'') et les montants (48', 48'') définissant ledit quadrilatère articulé (20), dans lequel
 - chacun des montants (48', 48'') guide et porte une fusée (56) d'une roue avant (10', 10''), chaque montant (48', 48'') s'étendant depuis une extrémité supérieure (60) vers une extrémité inférieure (64),
 - dans lequel chaque fusée (56) est mécaniquement reliée à une goupille de rotation (68) de la roue avant respective (10', 10'') de manière à porter en rotation la roue avant (10', 10'') autour d'un axe de rotation (R-R), et dans lequel chaque goupille de rotation (68) de la roue avant respective (10', 10'') est comprise entre l'extrémité supérieure (60) et l'extrémité inférieure (64) du montant correspondant (48', 48'') du quadrilatère articulé (20),
 - dans lequel, entre chaque fusée (56) et le montant respectif (48'), sont agencés des moyens de suspension (92) de la roue avant respective (10', 10''),
- caractérisé en ce que** chacun desdits montants (48', 48'') est creux de manière à loger intérieurement, au moins partiellement, lesdits moyens de suspension (92) de la roue avant respective (10', 10'').

2. Avant-train de véhicule automobile (8) selon la revendication 1, dans lequel chaque goupille de rotation (68) de la roue avant respective (10) est comprise entre des charnières latérales adjacentes (52) des traverses (24) du quadrilatère articulé (20).

3. Avant-train de véhicule automobile (8) selon la revendication 1 ou 2, dans lequel la fusée (56) de chaque roue avant (10', 10'') est portée et guidée par un unique montant gauche et droit correspondant (48', 48'') dudit quadrilatère articulé (20).

4. Avant-train de véhicule automobile (8) selon la revendication 1, 2 ou 3, dans lequel les montants gauche et droit (48', 48'') portent de manière rotative les roues avant gauche et droite (10', 10''), respectivement, autour d'axes de direction respectifs (S'-S', S''-S'') parallèles entre eux.

5. Avant-train de véhicule automobile (8) selon la revendication 4, dans lequel les charnières centrales (28) et les charnières latérales (52) sont parallèles entre elles et sont orientées de façon telle que, par rapport à un plan de projection (P) passant par lesdites charnières centrales (28), les axes de direction (S'-S', S''-S'') identifient, avec les axes de la charnière centrale (W-W) et de la charnière latérale (Z-Z), un angle (α), ledit angle α étant entre 80 et 120 degrés et, de préférence, ledit angle (α) étant entre 90 et 110 degrés.

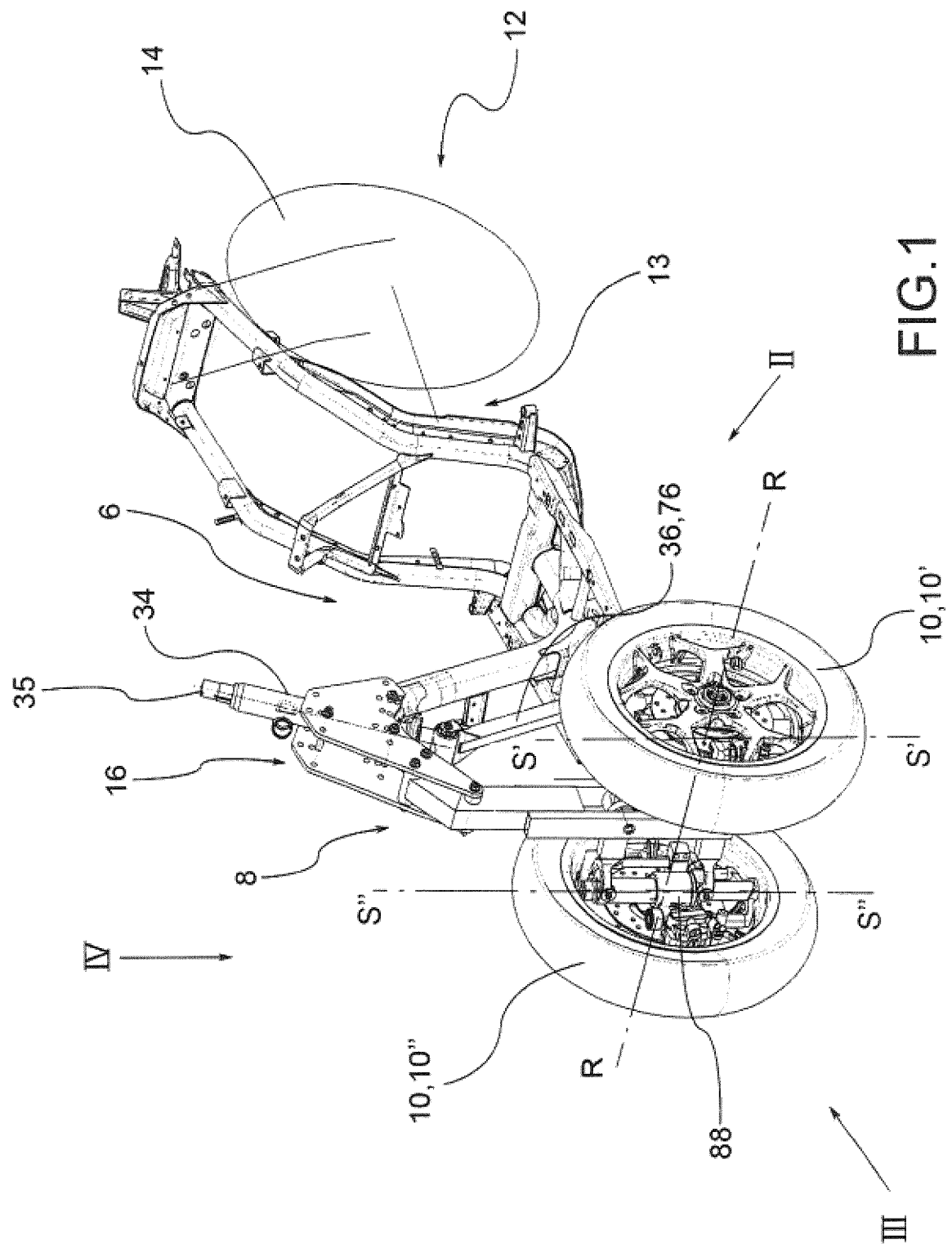
6. Avant-train de véhicule automobile (8) selon la revendication 4 ou 5, dans lequel les charnières centrales (28) et les charnières latérales (52) sont parallèles entre elles et orthogonales auxdits axes de direction (S'-S', S''-S'') de sorte que, par rapport à un plan de projection (P) passant par lesdites charnières centrales (28), les axes de direction (S'-S', S''-S'') identifient, avec les axes de la charnière centrale (W-W) et de la charnière latérale (Z-Z), un angle (α) de 90 degrés.

7. Avant-train de véhicule automobile (8) selon la revendication 4, 5 ou 6, dans lequel les axes de direction (S'-S', S''-S''), par rapport à un plan de projection (P) passant par lesdites charnières centrales (28), sont inclinés d'un angle de direction (β) entre 5 et 20 degrés, et de préférence entre 8 et 16 degrés, par rapport à une direction verticale (N-N), perpendiculaire au sol.

8. Avant-train de véhicule automobile (8) selon l'une quelconque des revendications précédentes, dans lequel les charnières centrales (28) et les charnières latérales (52) sont inclinées selon les axes de la charnière centrale (W-W) et de la charnière latérale (Z-Z) parallèlement au sol, c'est-à-dire perpendiculairement à une direction verticale (N-N) perpendiculaire au sol.

9. Avant-train de véhicule automobile (8) selon l'une quelconque des revendications précédentes, dans lequel chaque fusée (56) est montée sur un montant correspondant (48', 48'') de manière à posséder au moins un degré de liberté par rapport au montant correspondant (48', 48''), ledit au moins un degré de liberté comprenant un mouvement de translation de la fusée (56) par rapport au montant parallèlement à un axe d'extension dominante (T-T) du montant (48', 48'') et/ou un mouvement de rotation de la fusée

- (56) autour dudit axe d'extension dominante (T-T) du montant (48).
10. Avant-train de véhicule automobile (8) selon la revendication 9, dans lequel le raccord entre chaque fusée (56) et le montant (48', 48") est du type prismatique, de manière à n'autoriser qu'un seul degré de liberté à la fusée (56) par rapport au montant (48', 48"), c'est-à-dire une translation de la fusée (56) par rapport au montant (48', 48") parallèlement à un axe d'extension dominante (T-T) du montant (48', 48"). 5
 11. Avant-train de véhicule automobile (8) selon la revendication 9, dans lequel le raccord entre chaque fusée (56) et le montant (48', 48") est du type cylindrique, de manière à autoriser à la fois une translation et une rotation de la fusée (56) par rapport à l'axe d'extension dominante (T-T) du montant (48', 48"). 10
 12. Avant-train de véhicule automobile (8) selon la revendication 11, dans lequel chaque roue avant (10', 10") possède un axe de direction (S'-S', S"-S") qui coïncide avec l'axe d'extension dominante (T-T) et de symétrie du montant associé (48', 48") du type cylindrique. 15
 13. Avant-train de véhicule automobile (8) selon l'une quelconque des revendications précédentes, dans lequel l'avant-train (8) comprend au moins un support (72), relié à la fusée respective (56) de la roue avant respective (10', 10") et à des leviers de direction (76) de l'avant-train (8), de manière à commander la rotation des fusées respectives (56) autour de l'axe de direction respectif (S-S) de la roue avant respective (10', 10"). 20
 14. Avant-train de véhicule automobile (8) selon la revendication 13, dans lequel ledit support (72) porte des moyens de freinage (80) de la roue avant respective (10', 10"). 25
 15. Avant-train de véhicule automobile (8) selon la revendication 14, dans lequel lesdits moyens de freinage (80) comprennent un étrier pour frein à disque agencé à cheval sur un disque de frein (84) solidaire en rotation avec la roue avant (10', 10"). 30
 16. Avant-train de véhicule automobile (8) selon la revendication 13, 14 ou 15, dans lequel ledit support (72) s'étend à cheval sur le montant respectif (48', 48") à partir du côté de l'extrémité inférieure (64) du montant respectif (48', 48"). 35
 17. Avant-train de véhicule automobile (8) selon l'une quelconque des revendications précédentes, dans lequel la fusée (56) comprend un fourreau (88) agencé de manière coaxiale au montant (48', 48"). 40
 18. Avant-train de véhicule automobile (8) selon l'une quelconque des revendications précédentes, dans lequel lesdits moyens de suspension (92) comprennent un ressort (94) et/ou un amortisseur (96). 45
 19. Avant-train de véhicule automobile (8) selon l'une quelconque des revendications précédentes, dans lequel lesdits moyens de suspension (92) sont agencés de manière coaxiale au montant respectif (48', 48"). 50
 20. Avant-train de véhicule automobile (8) selon l'une quelconque des revendications précédentes, dans lequel chaque roue avant (10', 10") comprend une jante de roue (100) qui porte un pneu (102) et qui est portée en rotation par la fusée associée (56), dans lequel la fusée respective (56) est au moins partiellement logée dans un volume délimité par ladite jante de roue (100). 55
 21. Avant-train de véhicule automobile (8) selon la revendication 20, dans lequel la fusée respective (56) et le montant respectif (48', 48") sont intégralement logés dans ledit volume délimité par la jante de roue (100).
 22. Avant-train de véhicule automobile (8) selon la revendication 20 ou 21, dans lequel ledit volume fait face à un plan médian (M-M) de l'avant-train (8) passant par lesdites charnières centrales (28).
 23. Avant-train de véhicule automobile (8) selon l'une quelconque des revendications précédentes, dans lequel lesdites charnières centrales (28) et charnières latérales (52) sont orientées selon les axes de la charnière centrale (W-W) et de la charnière latérale (Z-Z) parallèlement entre eux.
 24. Véhicule automobile (4) ayant une roue motrice au niveau d'un essieu arrière (12) et un avant-train (8) selon l'une quelconque des revendications 1 à 23.
 25. Véhicule automobile (4) selon la revendication 24, dans lequel le véhicule automobile (4) comprend deux roues motrices arrière (14) au niveau de l'essieu arrière (12).
 26. Véhicule à moteur (4) selon la revendication 25, dans lequel lesdites roues motrices arrière (14) au niveau de l'essieu arrière (12) sont reliées entre elles et à un châssis d'essieu arrière au moyen d'un quadrilatère articulé (20) selon le quadrilatère articulé (20) de l'avant-train (8) de l'une quelconque des revendications 1 à 23.



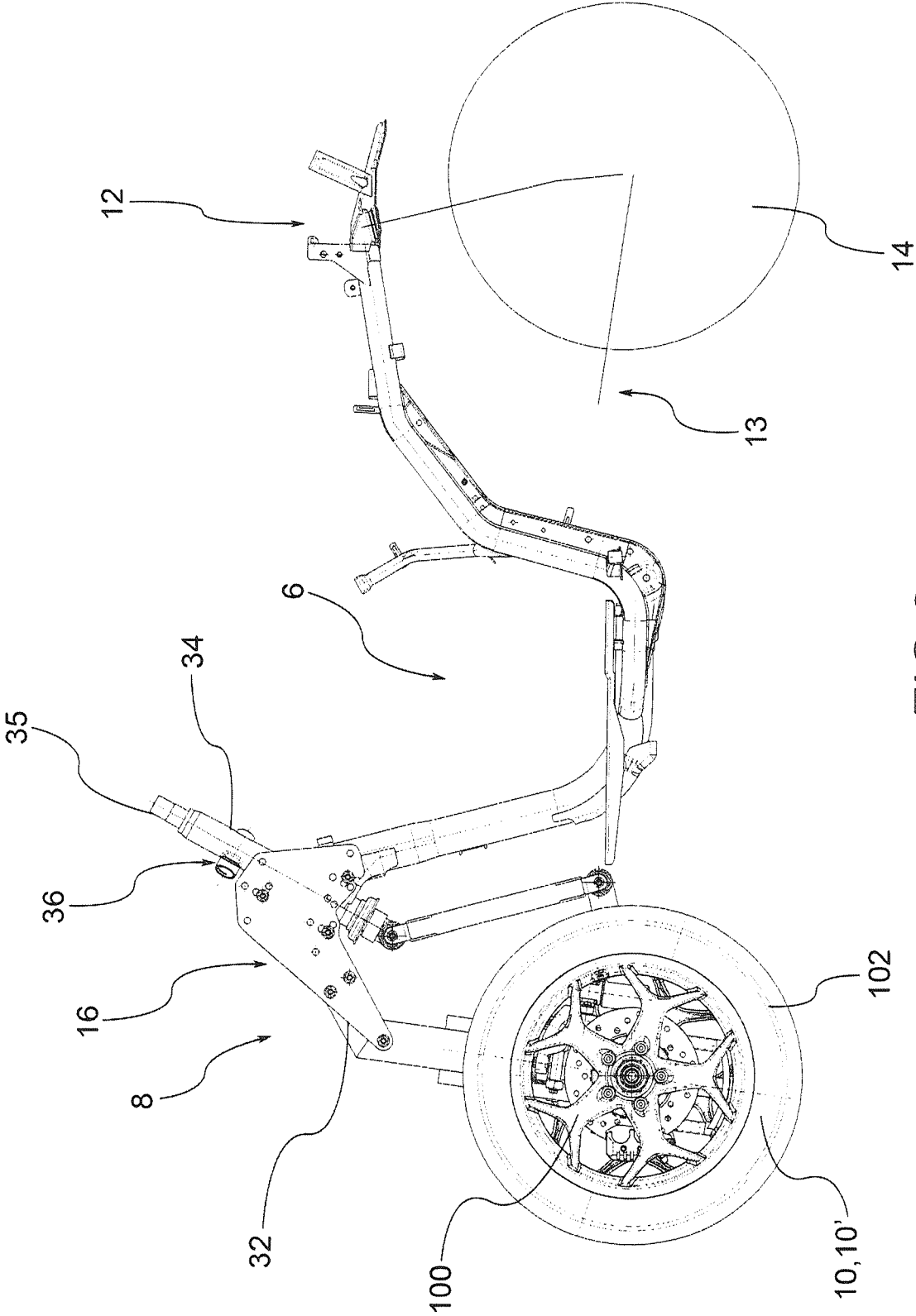


FIG.2

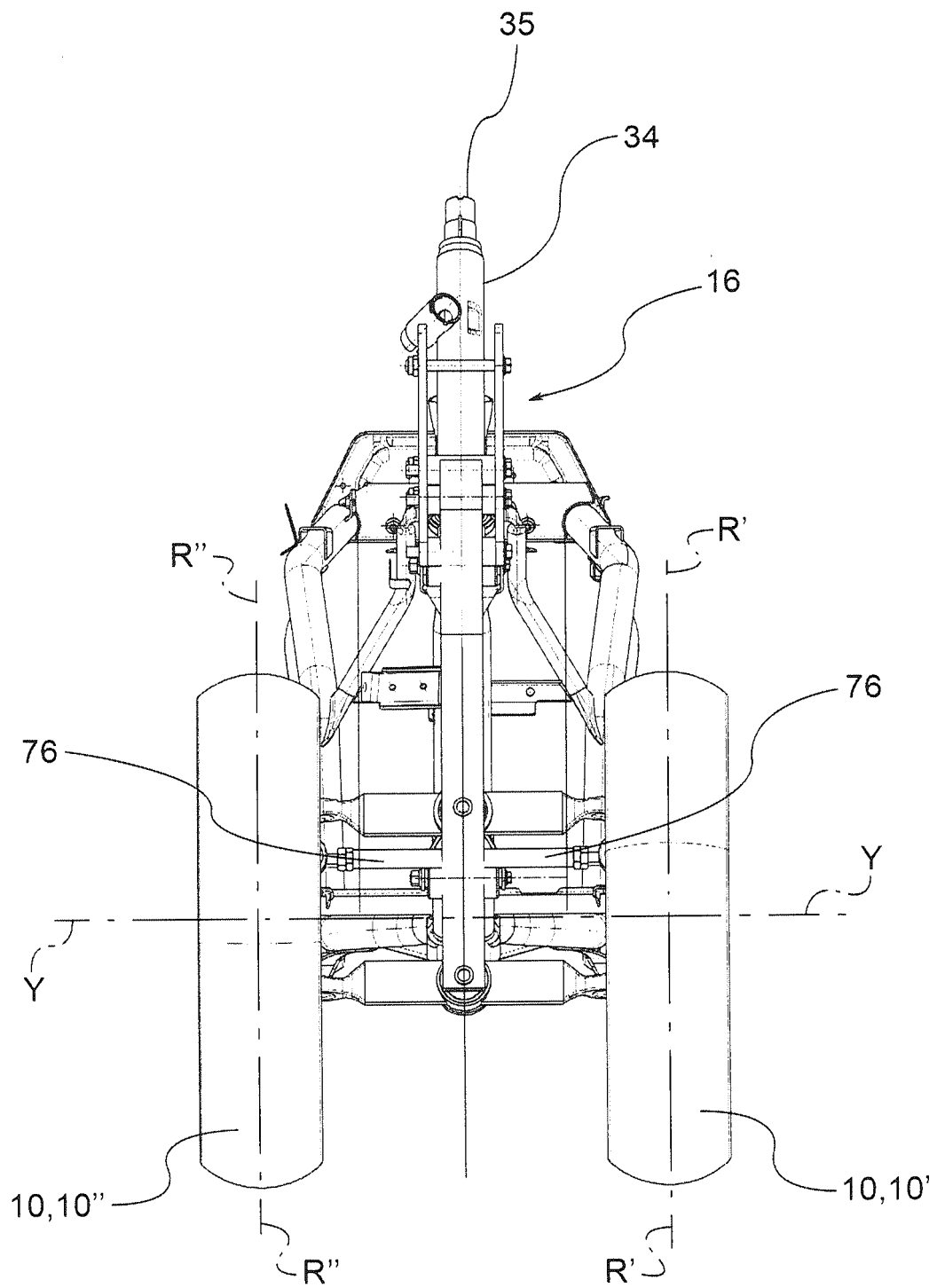


FIG.3

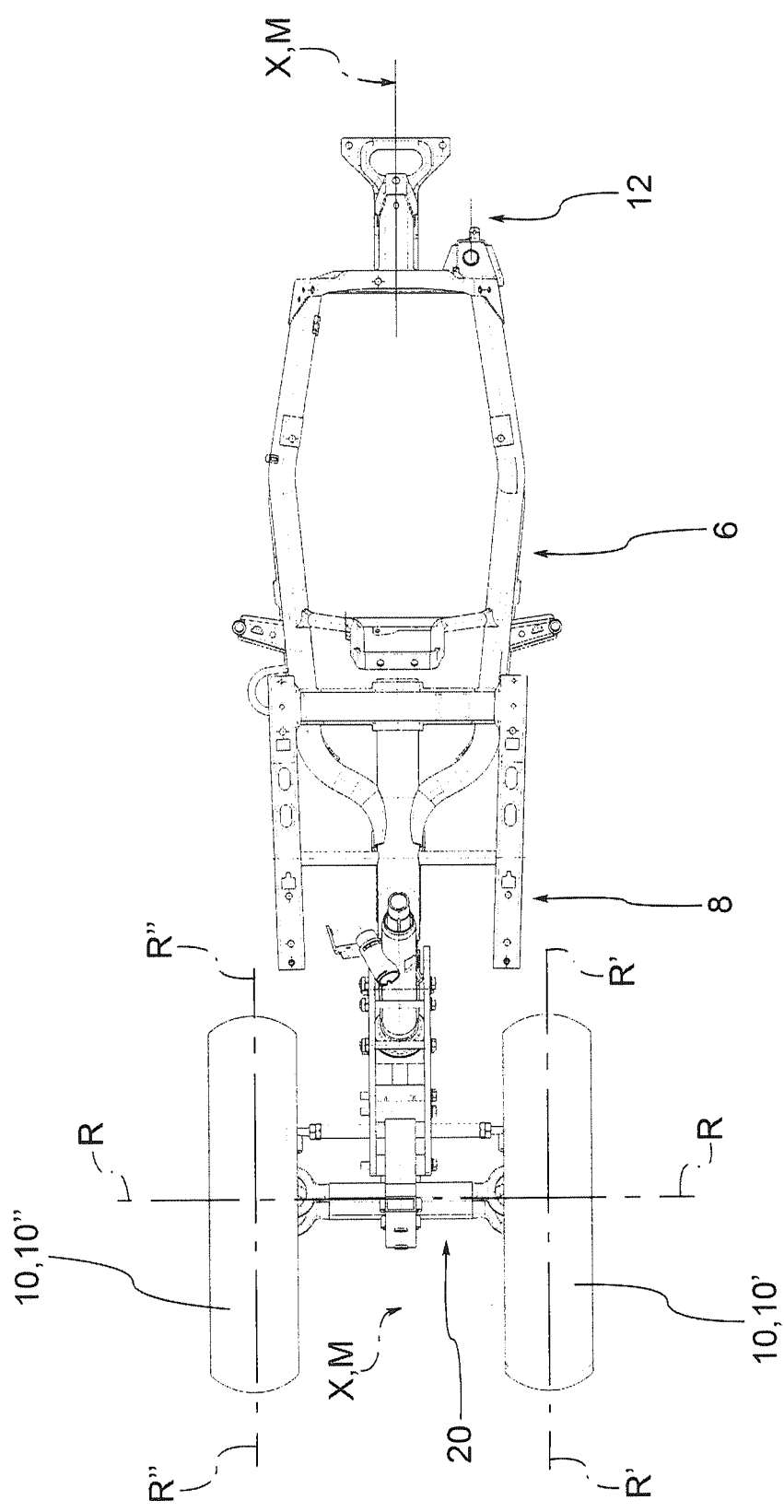


FIG.4

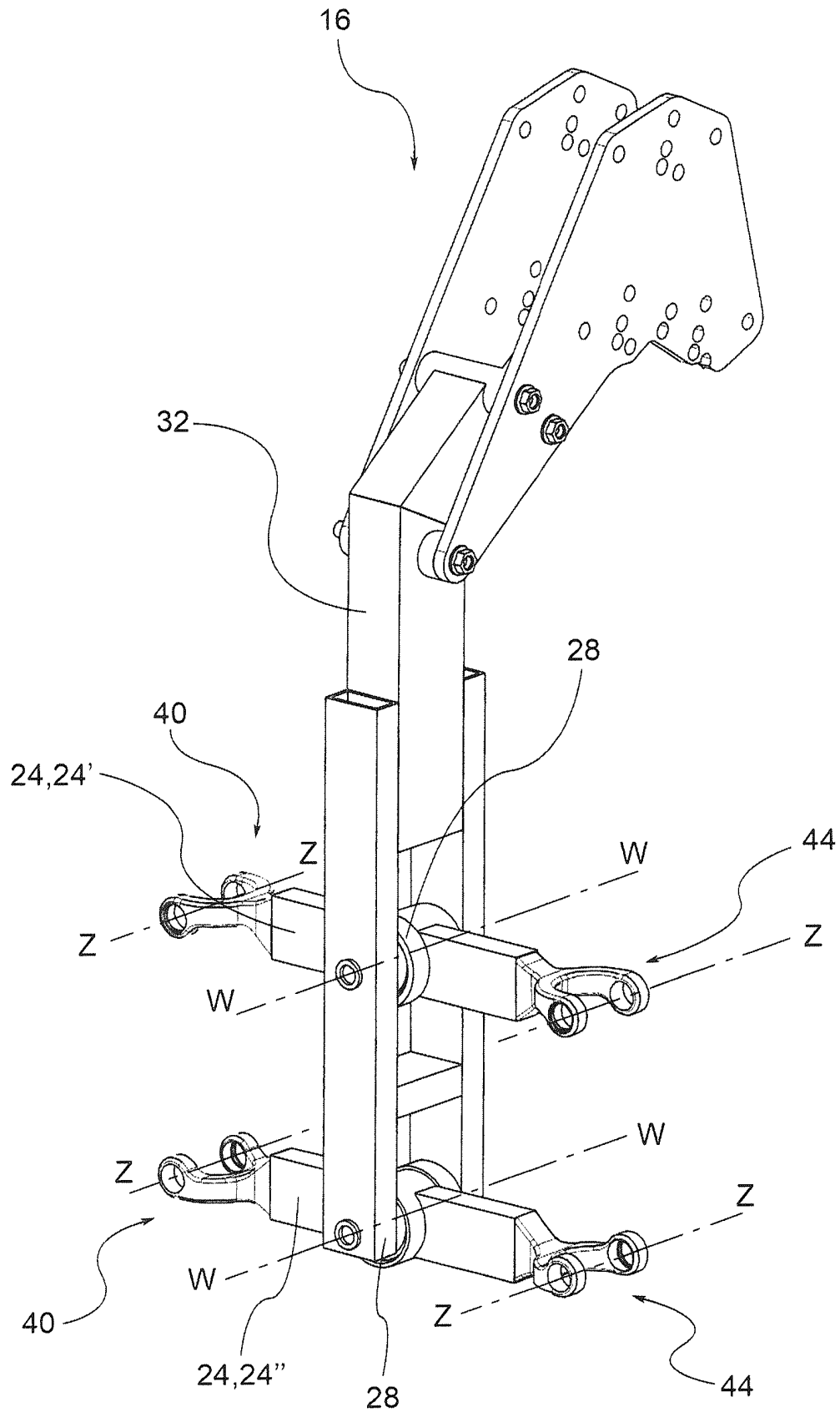


FIG.5

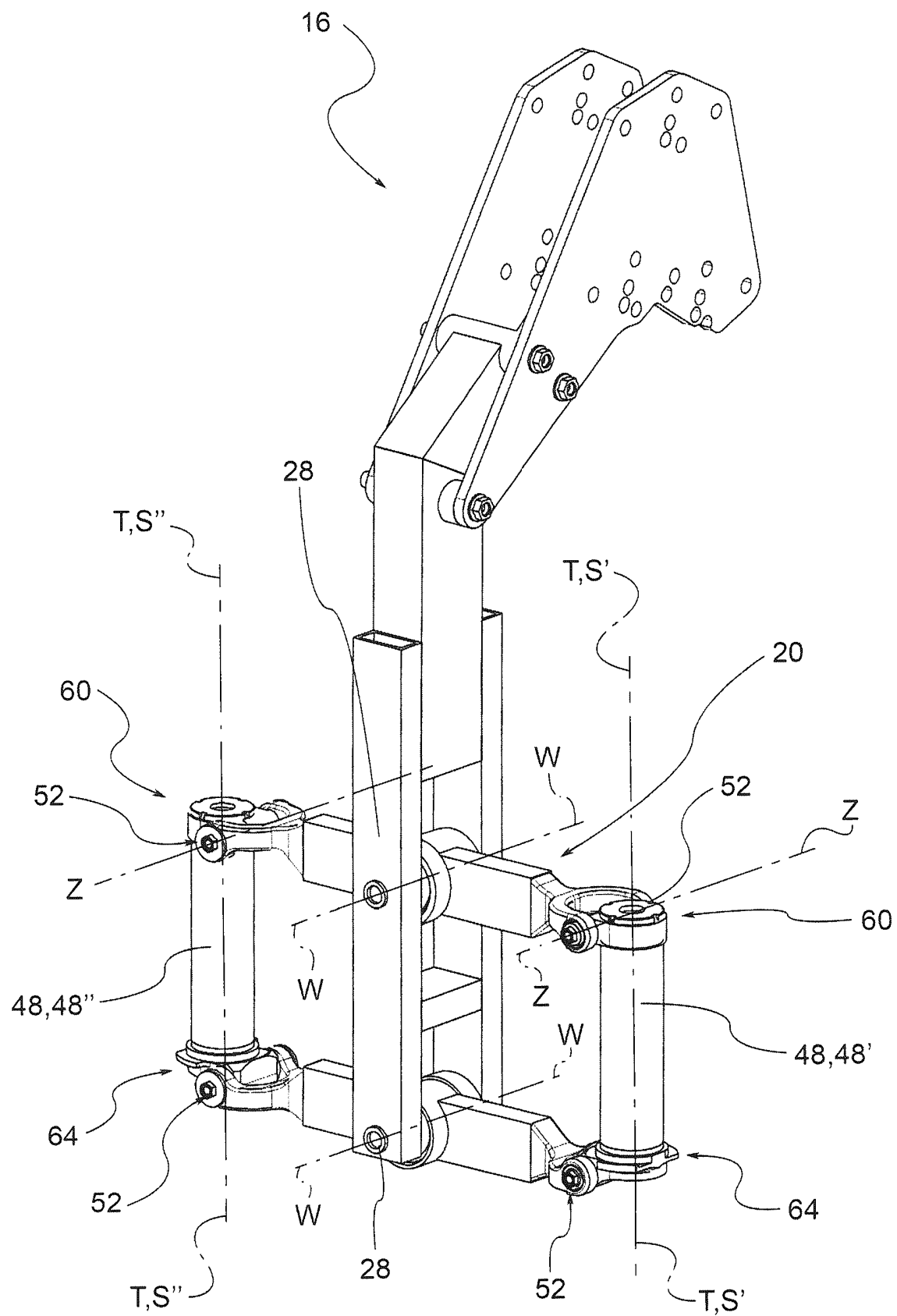


FIG. 6

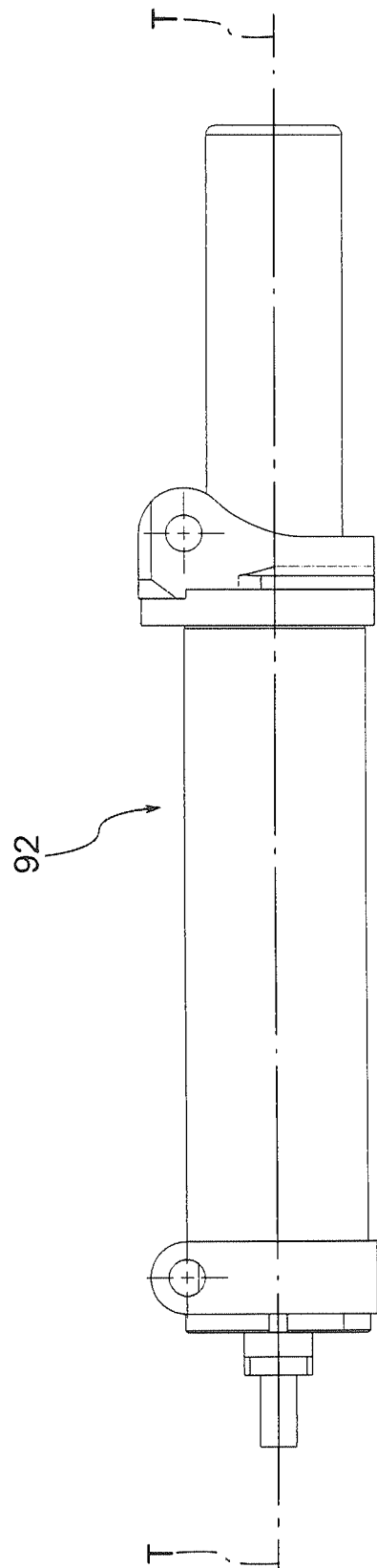


FIG. 7a

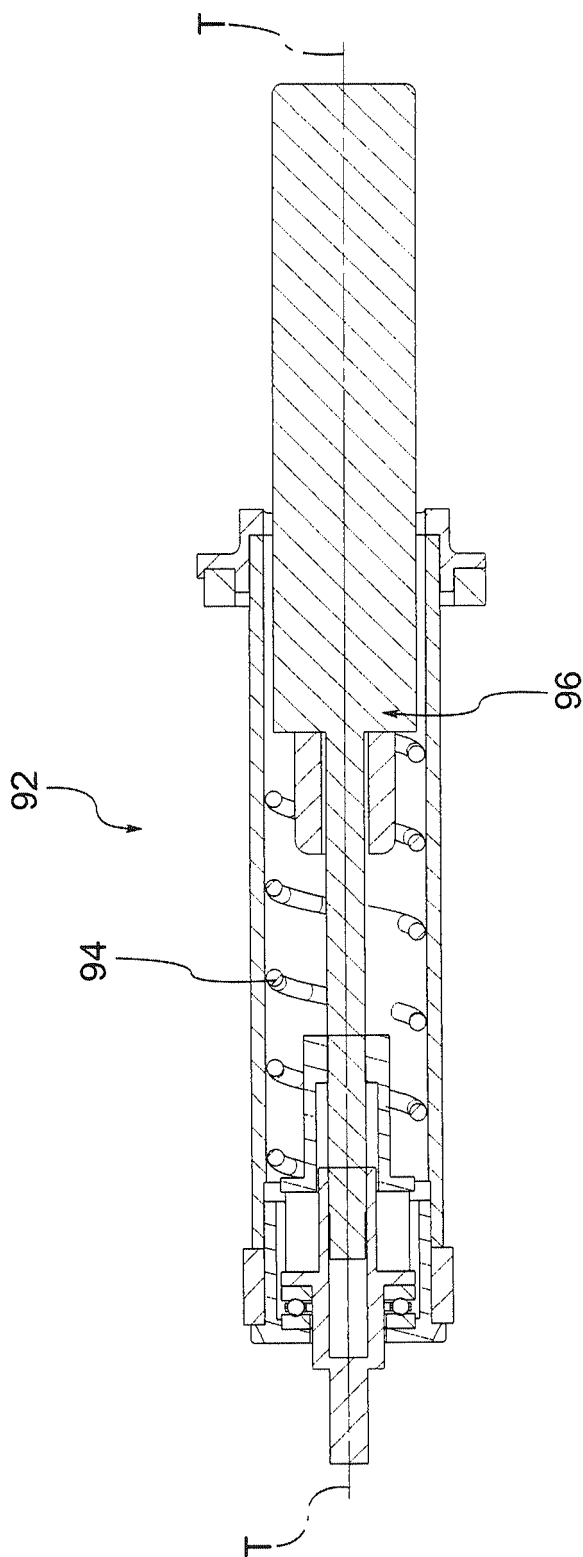


FIG. 7b

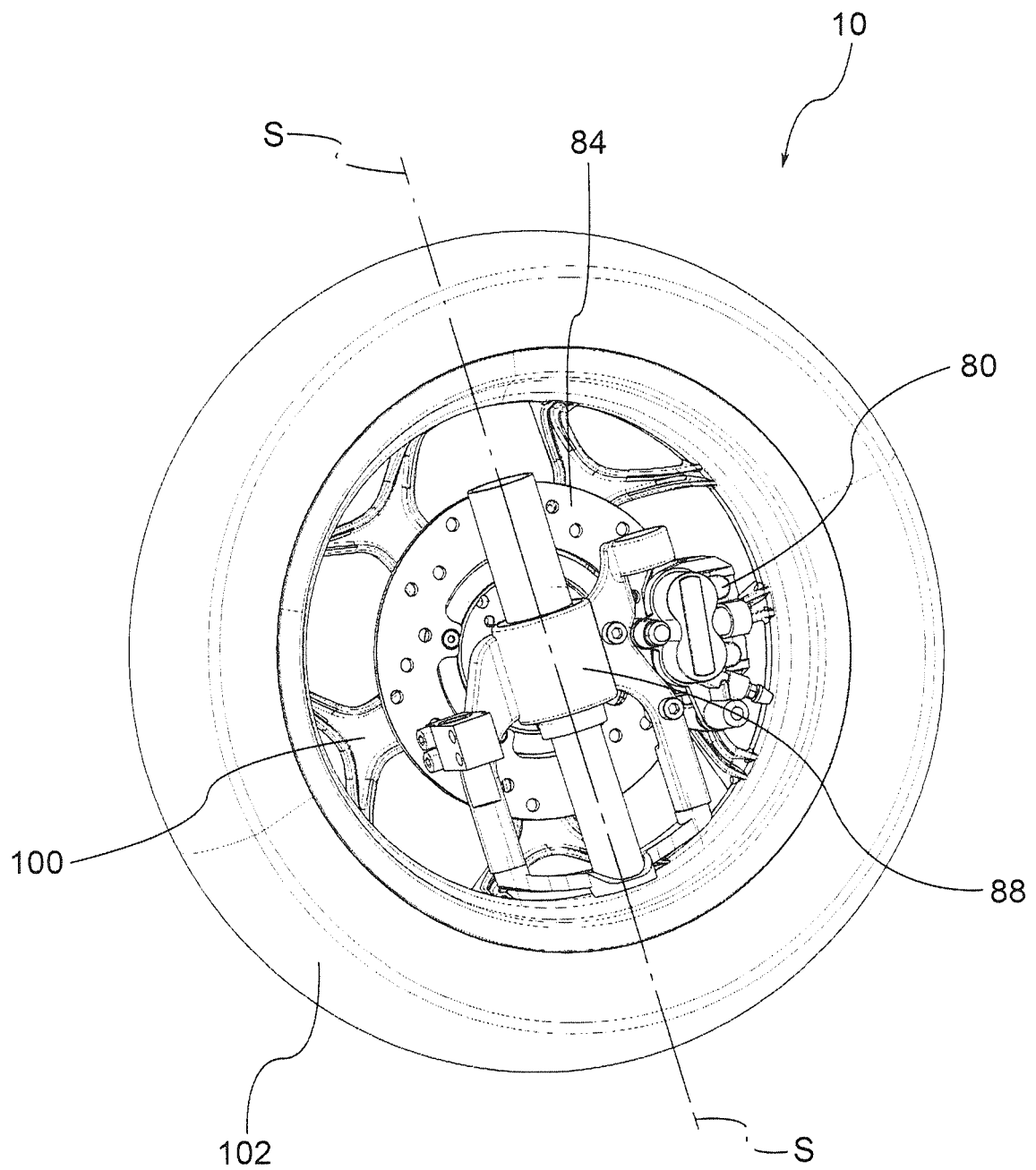


FIG.8

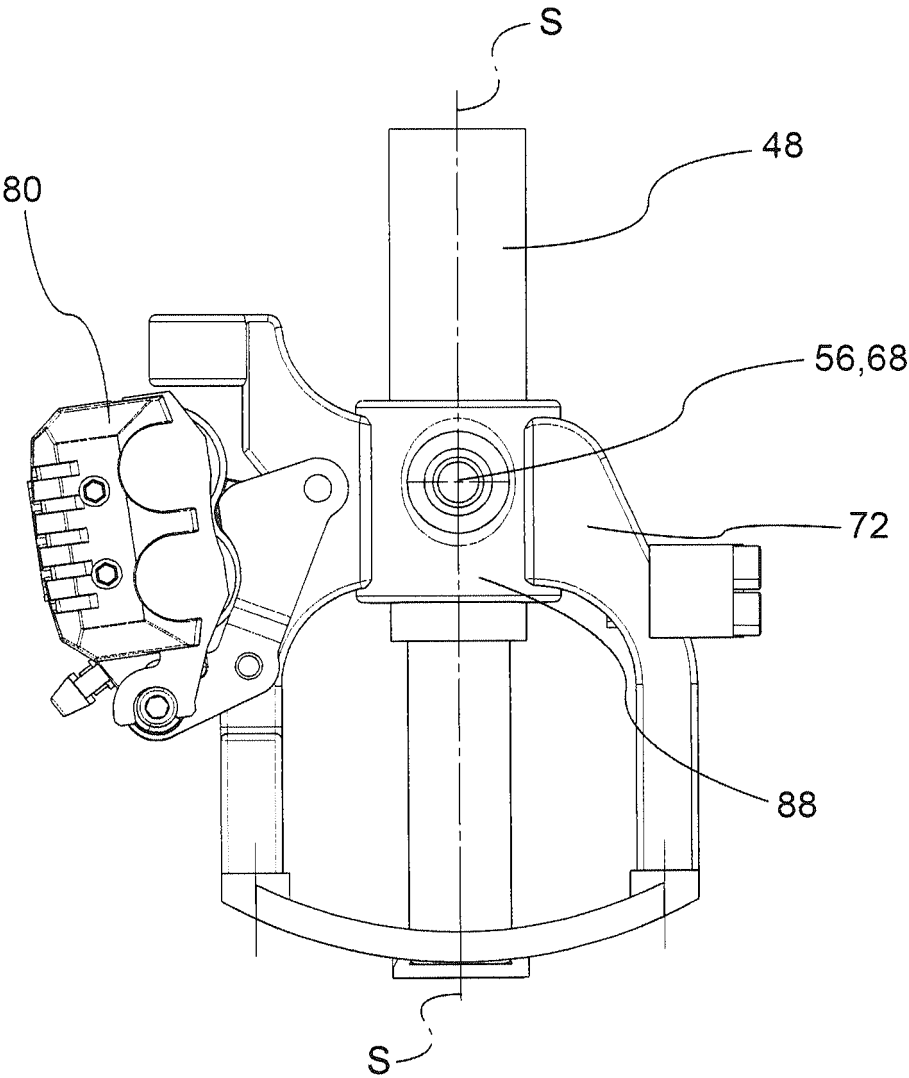


FIG.9

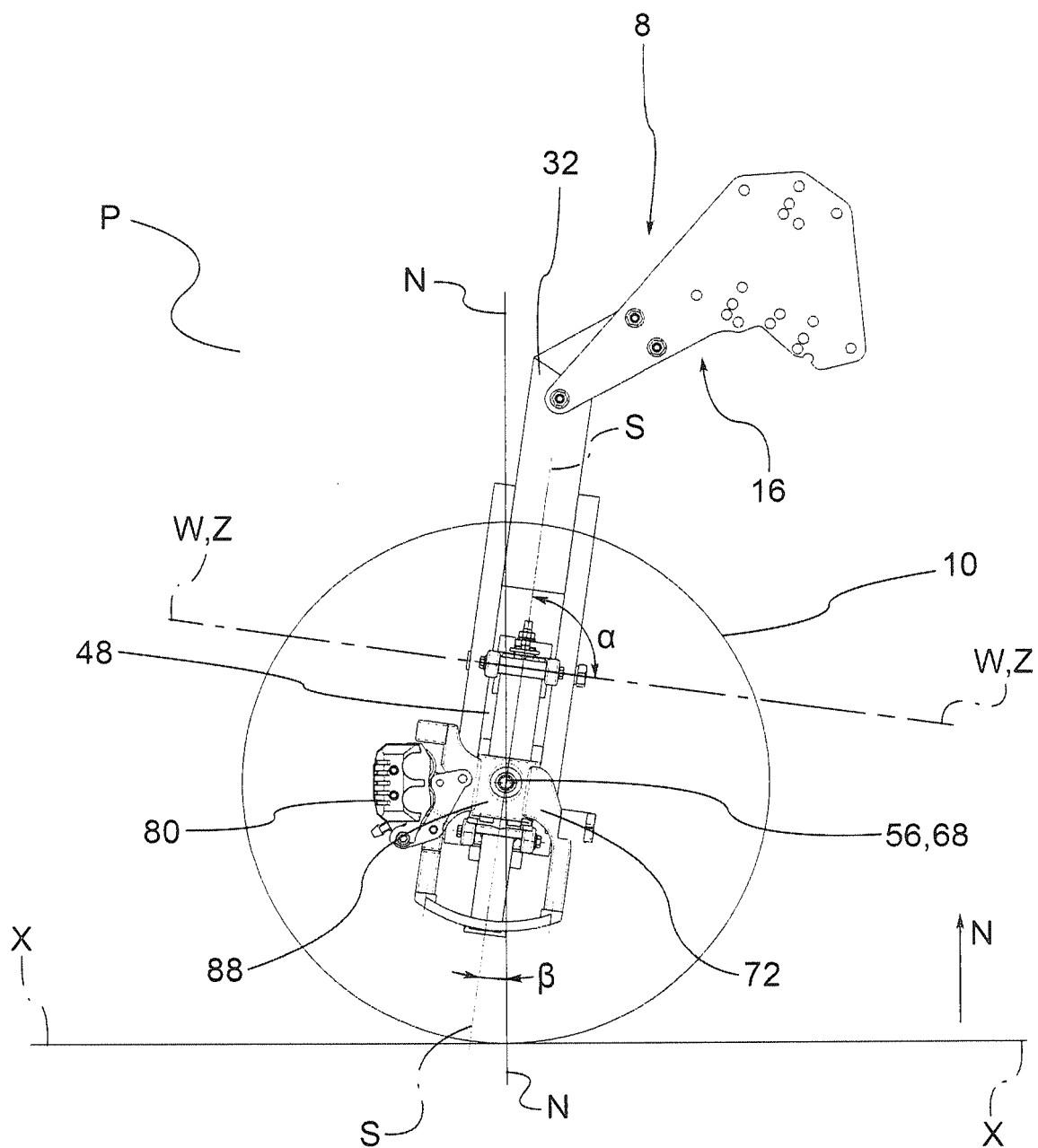


FIG. 10

REFERENCES CITED IN THE DESCRIPTION

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